

it evolved to a science and finally to an industry. It is good reading, copiously referenced, carefully indexed, an authoritative look at the past, present and future of health care in America.

One conclusion is unmistakable: The day of the \$5 a minute medical fee will soon be over.

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## REFERENCE

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## The Greatest Risks of Nuclear Power

TO THE EDITOR: Although I found the article by Hendee<sup>1</sup> on risks of medical radiation to be, for the most part, both interesting and enlightening, I believe that Figure 3 and the commentary on it in the text are both misleading and inaccurate. This figure, "adapted from Sinclair,"<sup>2</sup> compares the "actual risk," and the risk as perceived by various social groups (professionals, college students and League of Women Voters) in deaths per year for nuclear power and x-rays, to four other "societal activities" (smoking, motor vehicles, electric power, swimming). Sinclair,<sup>2</sup> however, only lists the rank order of 30 activities as perceived by these groups, and not projected death rates as the figure implies (that is, college students did not project 150,000 deaths per year as the figure shows but did rate nuclear power the most hazardous of 30 "societal activities" that also included swimming, bicycling, mountain climbing, skiing and school football). While Hendee states that nuclear power is the *least* hazardous of the 30 activities listed by Sinclair, Sinclair lists nuclear power 20th, accounting for an estimated 100 deaths per year, four times that of power mowers and school football, five times that of skiing and ten times that of vaccinations, and has no statistics for five of the activities. Hendee does not mention that x-rays were ranked ninth on the list with an estimated 2,300 deaths per year. Hendee does not state how the numbers for the "actual risks" (100 deaths per year per nuclear power) were obtained. While the deaths per year of motor vehicles or school football are probably easily obtainable, the calculation of risk of nuclear power or x-rays must take into account numerous estimates and assumptions. Even if the calculated risks are correct and the danger to an individual person is less for nuclear power than it is for swimming or motor vehicles, the latter are risks the individual may choose not to take.

A recent letter to the editor of the *Annals of Internal Medicine*<sup>3</sup> complained that a paper was misleading because the authors failed to update the references in their literature review (something that is difficult, considering the present lag time between manuscript submission and publication). Hendee's paper does the opposite and fails to "backdate its references." Figure 3 is said to be "adapted from Sinclair." However, Sinclair presents the data in a different form with minimal explanation claiming adaptation from *Decision Research*, but references a paper in *Dun's Review* by Howard and Antilla.<sup>4</sup>

Howard and Antilla give unreferenced results of a public opinion poll conducted by a firm called Decision Research on how three groups ranked the risks of various products and activities. They say that the pollsters concluded that people are more willing to accept familiar controllable risks than less familiar, uncontrollable risks. They do not state how the "actual risks," were calculated.

Hence, Hendee's presentation makes light of the risks of nuclear power by making frivolous comparisons of distorted data taken out of context. Isn't it ironic that he complains about "well meaning scientists and political action groups" who distort the risks of radiation exposure? Although I am not personally panicked over the use of nuclear power, as a nonsmoker, nonskier, nonmotorcyclist and non-mountain climber, I find the risk of nuclear power greater to me personally. I appreciate that public safety does require some degree of regulation and safeguards for virtually all of the 30 activities listed (such as motor vehicles, handguns, motorcycles, private aviation, commercial aviation, prescription medications and pesticides).

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## REFERENCES

1. Hendee WR: Real and Perceived risks of medical radiation exposure. *West J Med* 1983 Mar; 138:380-386
2. Sinclair WK: Effects of low-level radiation and comparative risks. *Radiology* 1981; 138:1-9
3. Warner BA, Cooper DS, Ridgeway EC: The medical-literature system: Gold or gold-plated? *Ann Int Med* 1983; 98:562
4. Howard N, Antilla S: What price safety? The zero-risk debate. *Dun's Review* 1979; 114:48-57

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TO THE EDITOR: William Hendee, in "Real and Perceived Risks of Medical Radiation Exposure,"<sup>1</sup> makes the parenthetical point that nuclear power is vastly overrated as a hazard based on his graphic representation of public opinion research previously reported in *Radiology*.<sup>2</sup> A few details of his analysis merit comment.

The fact that Dr Hendee has converted ordinal to cardinal data in order to present the original opinion ranking on the same scale with "actual risks" (deaths per year) is more excusable than is his statement "nuclear power is the least hazardous of all 30 of the activities included in the poll." In actuality, it was listed as number 20 in the source he cited.<sup>2</sup>

Central to his argument is the estimate of 100 "actual" deaths per year for nuclear power.<sup>2</sup> With 75 operating nuclear power plants, this corresponds to a figure of about 1.3 deaths per plant-year of operation, which is within the range of 0.07 to 2 quoted in one study.<sup>3</sup> However, subsumed within this total are 0.07 to 0.3 deaths per reactor-year due to "long-lived isotopes in waste gases, *discounted at 5 percent*" [italics mine]. The need for discounting is explained: "The radioactive gas radon will continue to be produced in uranium mill tailings and uranium mines for tens of thousands of years . . . and will apparently inflict small but continuous health risks on future generations. If

all the predicted deaths over all future years were to be added up, the totals would be very large, 100 to 800 per plant-year."<sup>3</sup> Multiplied by 75 plants, this corresponds with 7,500 to 60,000 deaths per plant-year, moving nuclear power up to between third and sixth place, in the company of motor vehicles and handguns.<sup>2</sup>

The philosophical question of discounting future deaths, "just as future incomes are discounted to represent the smaller value of future events in present-day calculations,"<sup>3</sup> need not be argued here. What is important is that, contrary to popular perception, the greatest risks from nuclear power may accrue in the uranium mining states, where an estimated 140 million tons of uranium mill tailings lie unprotected in both isolated and populated regions.<sup>4</sup>

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2. Sinclair W: Effects of low-level radiation and comparative risk. *Radiology* 1981; 138:1-9
3. Schurr S, Darmstadter J, Perry H, et al: *Energy in America's Future*. Baltimore, Johns Hopkins, 1979
4. Carter L: Uranium mill tailings: Congress addresses a long-neglected problem. *Science* 1978; 202:191-195

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## Dr Hendee Responds

TO THE EDITOR: In my article "Real and Perceived Risks of Medical Radiation Exposure," Figure 3 is a histogram of estimated deaths per year from selected societal activities compared with those from medical x-rays and nuclear power computed by assuming a linear relationship between dose and effect. In all likelihood, this computational procedure overestimates the hazard of x-rays and nuclear power. Superimposed upon the histogram is the perception of relative risk of the activities as revealed by a public opinion poll con-

ducted, as credited in our article, by Decision Research, Inc. The superimposition was provided to illustrate the disparity between real and perceived risks; it was not our intention to imply that the perception of risk is a quantifiable parameter in terms of deaths per year, and this interpretation by Shiffman and Shusterman is a bit surprising.

The argument of freedom of choice in risk assumption is one that has been debated endlessly and to which I have little to contribute other than to suggest that in our society the freedom to choose among risks is probably more limited than we would like to believe. For example, few of us have the luxury to absolve ourselves completely from involvement with motor vehicles.

For reference to the public opinion poll data, Schiffman and Shusterman may wish to follow my example of contacting Decision Research, Inc. of Eugene, Oregon, directly. Dr Shusterman is correct in pointing out that nuclear power occupies the 20th, rather than the 30th, position on the actual risk scale; however, this position is appropriate only insofar as the estimated number of deaths per year from nuclear power has some validity.

In the summary of my paper, the point is made that "multiplying this immeasurably small estimate of risk by very large populations yields numbers that seem to imply that significant health effects occur following exposure to small quantities of radiation." I appreciate the fine illustration of this point furnished by Dr Shusterman.

I do not believe that the accusation of "making frivolous comparisons of distorted data taken out of context" warrants any comment.

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